

<https://doi.org/10.7250/scee.2022.004>

SYSTEMATIC QUALITY IMPROVEMENT OF THE STUDY PROGRAMME: QUALITY FUNCTION DEPLOYMENT

**Irina DEGTJARJOVA, Inga LAPIŅA, Daira ARAMINA,
Jolanta JANAUSKA, Jānis PILDAVS, Jānis MAZAIS**

Riga Technical University, Riga, Latvia

Corresponding author e-mail: inga.lapina@rtu.lv

Abstract. Quality Function Deployment (QFD) is a well-known quality improvement and assessment methodology that can be applied in different fields, including higher education. The principle of continuous improvement refers to the study process and also relates to the initial analysis of the content of the study program and the systematic improvement process. The research aims to analyse and assess the Quality Function Deployment methodology application for the study program improvement, particularly focusing on the program quality assessment. Research methodology and results provide an opportunity to determine the high-priority skills, professional requirements and the significance of those study program components that create students' opinions about the importance of learning outcomes according to the professional competence they need and expect. The research results show how QFD methodology can be used to assess and improve study programmes in higher education institutions and indicate the benefits of the methodology application.

Keywords: *quality function deployment, quality improvement, study program quality, competences and learning outcomes.*

JEL Classification: I23, I25, L15, P36, P46

INTRODUCTION

Higher education institutions (thereafter – HEIs) need to create a learning environment that enables students to self-actualize and develop the competence required for future professional performance. What are the future professional competences? It is impossible to say unambiguously, but it is indisputable that in the labour market, a person's competence is becoming more and more important than the formal qualification they have acquired. Personal traits and competences such as creativity, innovativeness, adaptability, resilience and critical thinking, as well as emotional intelligence, are becoming more important than the knowledge gained in formal education. The relationship between employee's socio-demographic characteristics and employability and labour market conditions and innovation ecosystem becoming stronger (Dubickis & Gaile-Sarkane, 2021; Ozolina-Ozola & Gaile-Sarkane, 2017), and it leads HEIs to develop approaches that are more efficient in creating a contemporary learning environment. Lifelong learning is becoming an important part of the education system.

There are several quality models in education: the goal and specification model, resource-input model, process model, satisfaction model, legitimacy model, absence of problems model and organizational learning model (Cheng & Tam, 1997). A system approach program evaluation model for quality in higher education includes five systems divided into three groups: social; technical system input, transforming process and output; and managerial system (Mizikaci, 2006). Quality can be seen as a comparison of product features, as a precise and measurable value, as conformity to specifications, and as meeting or exceeding customer expectations (Garvin, 1984). Quality can be looked at from different perspectives: product-based (incl. characteristics of products), user-based (incl. users' needs and wishes), value-based (incl. users' evaluation and attitude), manufacturing-based (incl. compliance with specifications) and others.

According to ISO 9000:2015. Quality management systems – Fundamentals and vocabulary”, quality has two perspectives – organizational and product/service. The organisational perspective includes culture, behaviour, attitude, actions and processes that ensure value in order to meet the needs and wishes of the stakeholders, whereas the product/service perspective is the ability to satisfy and influence stakeholders in predictable and unpredictable ways – both at the functional and value levels. According to ISO 21001:2018. Educational organizations – Management systems for educational organizations – Requirements with guidance for use”, there is a critical and continuous need for educational organizations to evaluate the degree to which they meet the requirements of learners and other beneficiaries, as well as other relevant interested parties and to improve their ability to continue to do so. This standard provides a common management tool for organizations providing educational products and services capable of meeting learners' and other beneficiaries' requirements.

The principle of continuous improvement refers to the study process and relates to the initial analysis of the content of the study program, programme management, and systematic quality improvement. HEIs should create a systemic approach to quality assurance – a framework with a strict external structure and sufficient internal flexibility. This will ensure both compliance with external requirements and acquisition of compulsory education content, as well as student participation to the extent that their voice is heard and they are actively involved in quality assurance in higher education. Quality Function Deployment (thereafter – QFD) is a well-known quality improvement and assessment methodology that can be applied in different fields, including higher education. The research aims to analyse and assess the Quality Function Deployment methodology application for the study program improvement, particularly focusing on the program quality assessment. Our empirical research results provide the staff of HEIs involved in quality assessment with practical insight into the application of the QFD methodology for the management and improvement of study programs.

1. QUALITY ASSESSMENT IN HIGHER EDUCATION AND QFD METHODOLOGY: LITERATURE REVIEW

The quality of higher education is influenced by several factors and various circumstances, such as external and internal possibilities, limitations, requirements and risks. At least three approaches are used in quality assessment:

- external conformity assessment, when quality is evaluated by external experts using external assessment criteria (for example, accreditation, ranking);
- internal conformity assessment, when quality is evaluated by the staff of the HEI, using internal and external assessment criteria (for example, within the framework of the annual evaluation of the institution's performance);
- and internal continuous assessment, when the staff of the HEI is constantly performing quality assessment in their daily work): planning their activities according to the HEI's aims and needs, analysing quality indicators and acting accordingly. They are not managed from the outside; they are driven by self-motivation and self-regulation. This approach ensures closer cooperation and stakeholders' in-depth involvement.

Students' assessment of the quality of studies and their satisfaction with the study process have a crucial role (Chapleo & Sims 2017; Degtjarjova et al., 2018; Lapina et al., 2016; Marić, 2013). There are many well-known approaches and methodologies, such as the Kano model, SERVQUAL, SERVPERF, HEdPERF, QFD and others that are widely used for quality assessment and students' satisfaction evaluation in the context of the provided theoretical knowledge and practical skills (Abdullah, 2005, 2006a, 2006b, 2006c; Băcilă et al., 2014; Banahene, 2018; Brochado, 2009; Firdaus, 2006; Gupta & Srivastava, 2011; Silva, 2017; Nikoloski et al., 2013; Parasuraman et al., 1988; Parasuraman et al., 1991).

QFD is one of the popular approaches for evaluating quality, it is a powerful tool to evaluate and/or build a study program, to match customer requirements with the necessary corresponding design elements (Aytac & Deniz, 2005; Bier & Cornesky, 2001; Ermer, 1995; Tsinidou et al., 2010). QFD can be applied for process and design improvement, it could be used for visualising cause-and-effect relationships starting from the customer needs all the way down to the production process (Aytac & Deniz, 2005; Hwang & Teo, 2001; Singh et al., 2008). QFD is useful for determining the importance of elements, keeping the ability to respond to external changes on time (Motwani & Mazur, 2001; Sanford, 2005). The information included in the QFD matrix allows simultaneous research, planning, decision-making and improvement of the study program (Chaplin & Akao, 2003).

For the authors of this research, it was important to choose a method that would help to obtain information about skill importance as well as about the opportunities to acquire skills and satisfy students' needs within the study program. The QFD methodology was the most appropriate, as it allows us to determine relationships precisely and evaluate the strength of relationships between skills and study courses.

2. APPLICATION OF THE QFD METHODOLOGY: EMPIRICAL RESEARCH

2.1. Methodology

In order to test the QFD methodology appropriateness for the study programme quality assessment and improvement, the professional master study program "Total Quality Management" was selected and the QFD matrix was prepared (see Table 1). The skills demanded by the labour market were placed in the first (vertical) column of the matrix, and the study courses were placed in the top (horizontal) row of the matrix.

Table 1. The QFD matrix for quality assessment of the study program
(created by the authors)

Study courses → Skills ↓	WF1	Study course 1	Study course 2	Study course 3	Study course 4	Study course 5	Study course 6	Study course 7	Study course 8	:	Study course 14
	WF2	WF2	WF2	WF2	WF2	WF2	WF2	WF2	WF2	WF2	WF2
Skill 1	WF1	RF	RF	RF							
Skill 2	WF1	RF	RF	RF							
Skill 3	WF1	RF	RF	RF							
...	WF1	RF	RF	RF							
Skill 20	WF1	RF	RF	RF							

A list of the 20 skills is determined by the qualification requirements (professional standard) of a “Quality Manager”. A list of 14 study courses (SC) was included in the matrix, as these are the study courses that provide professional skills development at the required level according to the qualification requirements (professional standard). In addition, students had the opportunity to add skills that are not mentioned in the QFD matrix but are important according to the student’s professional experience. However, students found the list well-designed and completed, so they did not add any skills.

For the purpose of the research, the authors of this study selected final-year students of the study program. The students took part in the research while they were working on Master theses after they had completed all the courses. The choice of the Master’s level program was deliberate and based on the fact that all students have work experience and are able to assess each skill and assign a relationship factor to each course. The research was repeated for six years, starting from the students who graduated in 2016.

The research has limitations as it is focused on the students’ opinions only. The focus is on student assessment of professional skills and to what extent these skills are acquired in the study program. The research does not include professional experts’ and academic staff’s opinions.

The QFD matrix allows evaluation of the weighted factor of each skill (WF1), the weighted factor of each study course (WF2) and the relationship factor (RF). In this research, students evaluated RF and WF1. Evaluation of WF2 was not included in this research.

2.2. Research results

According to the QFD methodology, WF1 was rated on a scale from 0 to 5. WF1 shows the importance of each skill and highlights the priority skills, as well as shows the influence of each of the skills on the professional competence that students need and expect.

The relationship factor (RF) shows the strength of relationships between each study course and each skill (see Table 2), it was rated on a scale from 0 to 10, where:

- 10 means strong connection (●),
- 5 means moderate connection (○), and
- 2 means weak connection (▽).

Table 2. The strength of relationships and the opportunity to acquire skills within all study courses (created by the authors)

Skills (S)	Study courses (SC)														Sum of RF	Relative, %	
	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14			
	Relationships between study courses and skills (RF)																
1.	○	○	▽	▽	○	▽	▽	▽	▽	○	▽	▽	▽			48	6.9
2.	●	○	▽	▽	▽	○	▽	▽	▽	▽	▽		▽			46	6.5
3.	○	○	▽	▽	▽	○	▽	▽	▽	▽	▽		▽			40	5.7
...	▽	▽	○	▽	▽	○		▽	▽	▽			▽			34	4.8
...	○	○	▽	▽	▽	○	▽		▽	▽	▽		▽			44	6.3
...	▽		▽	▽		●										27	3.8
...	○	▽	▽	▽	▽	▽	▽	▽	▽	▽			▽			39	5.5
...	▽			▽			▽	●								25	3.5
...	▽					▽			▽	▽	▽		●			28	4.0
...	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		36	5.2
19.	▽	▽	▽	▽	▽	▽				▽	▽	▽	▽	○		36	5.0
20.	▽	▽		▽	○	▽	▽		▽	▽	▽		▽			34	4.9

First, the strength of the relationship between each study course and each skill was assessed. RF shows students' assessment of the extent to which they have seen the opportunity to acquire each skill in each of the professional study courses (each cell value). RF shows exactly what skills are being developed and in which courses. The analysis was done in pairs: each skill was analysed against the goal and the learning outcomes of each study course (according to the syllabus of the particular course).

Second, the impact of study courses on skills acquisition or RF in the context of the skills was assessed. It shows the extent to which each study course influences the achievement of professional competence in the context of all skills, i.e., the impact of each study course while acquiring the professional qualification of a "Quality manager". A sum of relationship factor values was calculated vertically opposite each study course (absolute), and then the proportion of each study course (relative) was calculated (see Table 3).

Table 3. Relationship factors of study courses (created by the authors)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sum of RF	69	55	45	54	50	90	40	40	48	62	46	34	44	29
Relative, %	9.8	7.8	6.3	7.6	7.0	12.7	5.7	5.7	6.9	8.8	6.6	4.8	6.3	4.1

All the study courses where the students saw relationships with most of the skills gained a higher relative assessment – from 6.9 to 12.7. The students saw the development of most of the skills in seven study courses. This is in line with the aims and learning outcomes of these study courses.

Those were the core courses of the programme – for example, *SC1 Quality management* and *SC6 Integrated quality systems* which are most closely related to the “Quality manager” professional qualification.

The students are of the opinion that a lower impact on skills development is attributed to the study courses with one dominant skill. For example, *SC12 Research methodology* and *SC14 Foreign language (professional terminology)*, as these study courses show less relevance to professional qualification. These study courses gained a total relative score of 4.1 to 6.6.

The analysis of each of the study courses separately through all of the skills shows to what extent each study course influences the attainment of professional competence in the context of all skills (each column analysis) (see Table 4).

Table 4. The relationships of all skills within a particular study course (created by the authors)

Skills (S)	Study courses (SC)														Sum of RF	Relative, %
	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14		
	Relationships between study courses and skills (RF)															
1.	o	o	∇	∇	o	∇	∇	∇	∇	o	∇	∇	∇		48	6.9
2.	•	o	∇	∇	∇	o	∇	∇	∇	∇	∇		∇		46	6.5
3.	o	o	∇	∇	∇	o	∇	∇	∇	∇	∇		∇		40	5.7
4.	∇	∇	o	∇	∇	o		∇	∇	∇			∇		34	4.8
5.	o	∇	∇	∇	∇	•	∇		∇	∇	∇		∇		37	5.2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sum of RF	69	55	45	54	50	90	40	40	48	62	46	34	44	29
Relative, %	9.8	7.8	6.3	7.6	7.0	12.7	5.7	5.7	6.9	8.8	6.6	4.8	6.3	4.1

Third, the analysis of each skill separately through all of the study courses was performed. It shows to what extent each skill is acquired within the professional study courses as well as allows to assess to what extent students believe they have the opportunity to learn each skill within all study courses (each row analysis) (see Table 5). A sum of RF values was calculated horizontally opposite each skill (absolute number), and then the proportion of each skill (relative number) was calculated.

Based on the students’ opinions, the skills they were able to develop the most are the following: the ability to identify customer needs, apply quality management methods, build a quality management system, analyse processes, perform an internal audit, prepare a report etc. This is in line with the aims and learning outcomes of the main study courses and the whole study programme.

The final stage of the research includes the analysis of the importance of each skill or weighted factor (WF1) and a comparison of the relative values of WF1 and RF.

Table 5. The relationships of all study courses in the development of a particular skill (created by the authors)

Skills (S)	Study courses (SC)														Sum of RF	Relative, %
	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	SC13	SC14		
	Relationships between study courses and skills (RF)															
1.	o	o	∇	∇	o	∇	∇	∇	∇	o	∇	∇	∇		48	6.9
2.	•	o	∇	∇	∇	o	∇	∇	∇	∇	∇		∇		46	6.5
3.	o	o	∇	∇	∇	o	∇	∇	∇	∇	∇		∇		40	5.7
4.	∇	∇	o	∇	∇	o		∇	∇	∇			∇		34	4.8
5.	o	∇	∇	∇	∇	•	∇		∇	∇	∇		∇		37	5.2

WF1 shows the students' opinions on the importance of skills in the context of professional activity. The average value of the importance of each skill was calculated from the students' ratings throughout the years (see Table 6, Average WF1).

Table 6. Examples of skills importance and comparison of relative WF1 and RF (created by the authors)

Skills	Average WF1	Relative WF1, %	Δ	Relative RF, %
1. Identify customer needs	4.33	5.28	1.59	6.87
3. Analyse processes	4.53	5.54	0.12	5.66
4. Perform conformity assessment procedures	4.08	4.97	-0.15	4.82
5. Apply efficiency improvement methods	4.52	5.53	-0.31	5.22
6. Build a quality management system	4.70	5.75	0.51	6.26
10. Perform an internal audit, prepare a report	4.37	5.32	0.14	5.46
12. Apply risk assessment methods, assess potential hazards	3.97	4.83	-0.82	4.01
16. Assess and improve the corporate social responsibility program	3.78	4.63	-0.67	3.96
17. Choose the most appropriate research methodology, draw conclusions	2.93	3.56	1.60	5.16

As different scales (WF1 0-5 and RF 0-10) are used in the QFD matrix for WF1 and RF, all WF1 and RF values were converted to relative values and expressed in percentages. The authors of this study evaluated the difference between the importance of each skill (WF1) and the opportunity to acquire it during the studies (RF), and some examples are included in Table 6 (see column Δ). For example, the differences (column Δ) for skill 1 and skill 17 stand out with a positive value, but for skill 12 and skill 16 – with a negative value. A positive delta means that the opportunity to acquire the skill is

higher than the skill's importance for students, whereas a negative delta means that the opportunity to acquire the skill is insufficient in the students' view. A bigger delta means a bigger difference between the opportunity to acquire the skill and the importance of this particular skill. If the delta is negative, programme administration needs to pay more attention to the opportunity to acquire these skills and make changes in the programme.

The students' survey shows that student expectations are exceeded in those skills that are developed evenly in all or almost all courses, in comparison to the skills that are developed in a concentrated way in one or some of the courses. The accumulation of skills in small doses but steadily and constantly, in the students' perception, cumulatively form the greatest added value.

3. APPLICATION OF QFD FOR STUDY PROGRAMME QUALITY ASSESSMENT

The QFD methodology provides an opportunity to determine the students' high-priority needs, requirements and the significance of those study program components that create students' professional competence. A visual illustration can be obtained by organizing the aforementioned information in a matrix that demonstrates the significance of each study program component.

According to the Standards and Guidelines for Quality Assurance in the European Higher Education Area (thereafter – ESG) and the Law on Higher Education Institutions (thereafter – LHEI) in Latvia, there are several quality indicators implemented in quality assurance. Some of them are ensured at the HEI's strategic management level. Those indicators (i1, i2, i3, i4 and i5), whose provision can be affected at the level of the study program, were used in the research assessing whether QFD use allows obtaining the value of these indicators (see Figure 1).

The research highlights the application of the QFD methodology in assessing the implementation of the requirements of ESG 1.9 and LHEI. The indicative assessment shows the level of achievement of quality requirements, trends and elements of the study program.

The QFD methodology is used to gain the opinion of a student as a participant and an internal stakeholder (client) about the study program and to test the application of this approach for self-assessment.

Application of the QFD methodology can help to improve the operation of higher education institutions, and study process management in particular. If new professional knowledge is included in the study content on a regular basis and the academic staff is motivated to acquire topical knowledge and skills, the study process becomes more rational and effective, and it could save a lot of costs for the higher education institution.

Further research requires an in-depth analysis of the causes that influence student opinion about the strength of relationships between the study courses and skills, as well as an analysis of the importance of the study courses (WF2).

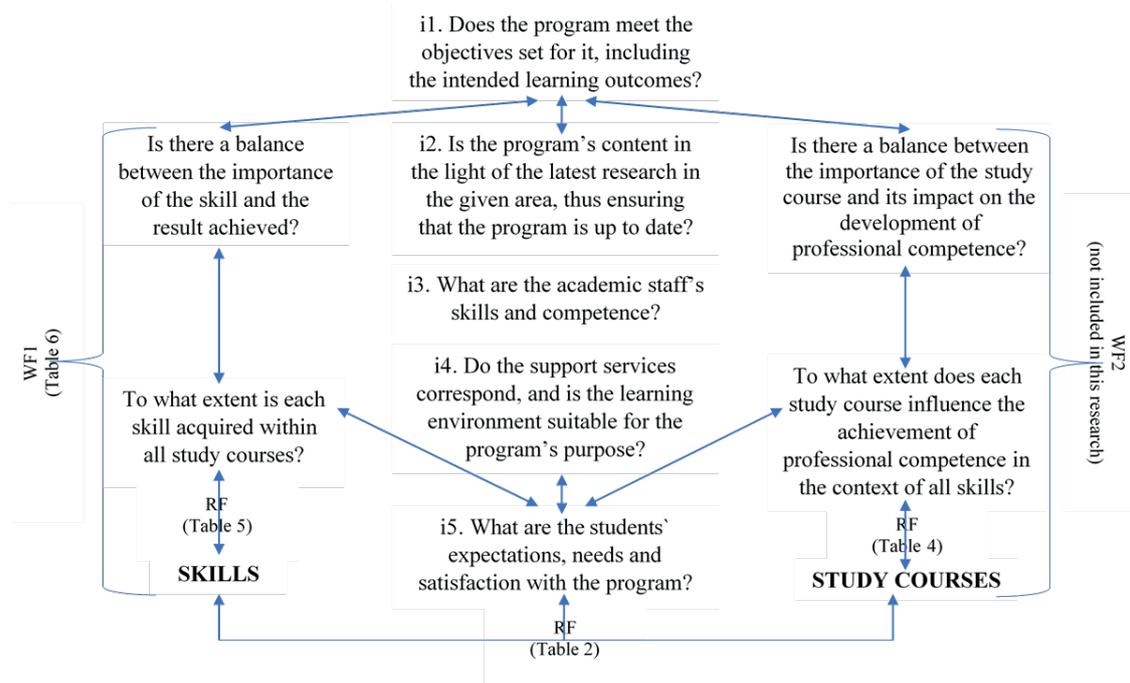


Fig. 1. Application of QFD for quality assessment of the study program (created by the authors).

Using the QFD methodology, respondents need very clear instructions because of the risk of misunderstanding, e.g., Does RF assess the skills provided by the higher education institution or the student's own efforts to make full use of these opportunities? Does WF assess the importance in the context of the future profession or in the context of personal attitude?

CONCLUSIONS

QFD is a well-known quality improvement and assessment methodology that can be applied in different fields, including higher education. The research helped to understand how the QFD methodology can be used for the assessment and improvement of the study process in higher education institutions. Student opinions about skills' importance as well as about the strength of relationships between skills and study courses were obtained. The strengths and weaknesses of the study program were highlighted: study courses with an insufficient level of skill performance and high-performance level were identified.

The results of the research show that the QFD methodology allows to evaluate the study program according to external requirements, to determine the causal relationships between the planned result (incl. learning outcomes) and the opportunity to achieve it, to obtain information about the deficiencies and facts for a deeper analysis of the reasons.

In terms of study quality, the QFD methodology can be widely used in HEIs in order to:

- find out the importance of skills and study courses, analyse study course impact on skill development and analyse the correlation between the mentioned indicators;

- conduct an in-depth study program analysis at the level of study courses;
- evaluate student satisfaction and purposefully develop cooperation with the student self-government;
- gain expert opinion on the importance of skills in the context of professional activity;
- purposefully develop cooperation with employers – compare learning outcomes with employers' requirements – both for the local labour market, which provides internship opportunities for students and employs graduates, and the international market, which is a litmus test for international competitiveness;
- analyse the trends and identify the need for study program improvement.

Using QFD on a regular basis, a common understanding between the stakeholders on the quality of the study program and a strong connection between skills and study courses can be achieved.

QFD use allows students to take an active role in creating the study process. The scope of QFD use can be expanded to include assessment of other quality requirements: whether the regulations that cover all the phases of a student life cycle are pre-defined and consistently applied; whether the internal procedures and mechanisms for assuring the qualifications of the academic staff and the work quality are developed; whether the processes are fair and transparent; whether the criteria, conditions and procedures for the evaluation of student results, which enable reassurance of the achievement of the anticipated study results, are developed and made public; whether the mechanisms for the creation of study programs, for internal approval, for supervision of activities and periodic audit, are developed, whether the funding for learning and teaching activities is adequate; whether learning resources are easily accessible; whether student support is provided; etc.

The range of stakeholders involved in the assessment can also be expanded, e.g., including industry experts to express their opinion on the importance of skills and student internship supervisors – to assess the performance of skills.

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AUTHORS' SHORT BIOGRAPHY



Irina Degtjarjova received the Master's degree in Management from University of Latvia. She is a researcher at the Institute for Quality Engineering at the Faculty of Engineering Economics and Management of Riga Technical University, as well Quality Management and System Development Manager at SJSC "LATVIJAS PASTS". She has practical experience in the field of quality of higher education and quality of services, i.e., process analysis, elimination of inconsistencies, business and system analysis, as well as the implementation of improvements. The area of her research interests: quality and process management and improvement, quality assurance in higher education, quality improvement of study programs.



Inga Lapina (Professor Dr) has more than 25 years of experience in higher education, research and project management, currently she is a Vice Dean at the Faculty of Engineering Economics and Management of Riga Technical University. She is passionate about delivering quality education that meets real-life business needs and fostering creativity, entrepreneurial spirit and innovative thinking among students. She strongly believes that out-of-the-box thinking, creativity and continuous improvement are crucial to success in business and life. The area of her research interests: quality management, conformity assessment, quality of education, development of human and intellectual capital and competence, corporate social responsibility and sustainability.

E-mail: inga.lapina@rtu.lv

ORCID iD: <https://orcid.org/0000-0003-3019-2472>



Daira Aramina received the Master of Business Administration (MBA) from Riga Technical University (RTU), Faculty of Engineering Economics and Management in 2008. She has worked at Riga Technical University since 1993; currently she is a Vice Dean at the Faculty of Engineering Economics and Management of Riga Technical University. The area of her research interests: human resource management in large organizations, human psychology, as well as development of human capital and competences and quality management, quality assurance in higher education, quality improvement of study programs.

Jolanta Janauska holds a Master's degree in Quality management. She has been working at Riga Technical University since 1977. In 2011 she joined the Department of Quality Technology of the Institute for Quality Engineering at Riga Technical University as an Assistant Professor in professional programmes. The area of her research interests: quality management, quality assurance in higher education, quality improvement of study programs.

Jānis Pildavs holds a Master's degree in Quality management. He has been working at Riga Technical University as a visiting teacher for more than 15 years. The area of his research interests: quality management, quality assurance, quality improvement and quality systems.

Jānis Mazais (Dr.sc.ing.) is Professor Emeritus at Riga Technical University, Faculty of Engineering Economics and Management. He had been working at Riga Technical University in different scientific and academic positions for more than 30 years. In addition, he has ten years' experience working with the United Nations Development Programme in the capacity of Operations Manager. The area of his research interests: quality and process management and improvement.